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FORM PTO-1390 REV. 5-93 US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEYS DOCKET NUMBER **P00,1291** U.S.APPLICATION NO. (if known, see 37 CFR 1.5) **09/582120**
INTERNATIONAL APPLICATION NO. **PCT/DE98/03813**	INTERNATIONAL FILING DATE **29 December 1998**	PRIORITY DATE CLAIMED **23 January 1998**

TITLE OF INVENTION
METHOD AND DETERMINATION DEVICE FOR THE IMPLEMENTATION OF THE METHOD FOR DETERMINING A CONNECTING PATH IN A COMMUNICATION NETWORK

APPLICANT(S) FOR DO/EO/US
Robert Liebl

Applicant herewith submits to the United States /Designated/Elected Office (DO/EO/US) the following items and other information:

1. ■ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. □ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ■ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ■ A proper Demand for International Preliminary Examination will be made by the 19th month from the earliest claimed priority date.
5. ■ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ■ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ has been transmitted by the International Bureau.
   c. □ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ■ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ■ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. □ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ have been transmitted by the International Bureau.
   c. □ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ■ have not been made and will not be made.
8. □ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ■ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **Executed**
10. ■ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ■ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report).**
12. ■ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ■ A FIRST preliminary amendment.
    □ A SECOND or SUBSEQUENT preliminary amendment.
14. □ A substitute specification.
15. □ A change of power of attorney and/or address letter.
16. ■ Other items or information:
    a. ■ Submission of Drawings - Three sheets of **Drawing - Submission of Corrected Drawings**
    b. ■ **EXPRESS MAIL #EL568800396US** dated June 22, 2000.

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 09/582120	INTERNATIONAL APPLICATION NO. PCT/DE98/03813	ATTORNEY'S DOCKET NUMBER P00,1291

BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):

Search Report has been prepared by the EPO or JPO $840.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) . . $670.00

No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $760.00

Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO $970.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) .... $ 96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =				$840.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$ 0	
Claims	Number Filed	Number Extra	Rate		
Total Claims	17 - 20 =	0	X $ 18.00	$0	
Independent Claims	2 - 3 =	0	X $ 78.00	$0	
Multiple Dependent Claims			$260.00 +	$	
TOTAL OF ABOVE CALCULATIONS =				$	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				$	
SUBTOTAL =				$	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$840.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +					
TOTAL FEES ENCLOSED =				$840.00	
				Amount to be refunded	$
				charged	$

a. ■ A check in the amount of $ 840.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ in the amount of $ ________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ■ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-2290. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Brett A Valiquet

SIGNATURE

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27,841

Registration Number

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BOX PCT

IN THE UNITED STATES ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: **ROBERT LIEBL**

DOCKET NO: P00,1291

SERIAL NO: GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE98/03813

INTERNATIONAL FILING DATE: 29 December 1998

INVENTION: **"METHOD AND DETERMINATION DEVICE FOR THE IMPLEMENTATION OF THE METHOD FOR DETERMINING A CONNECTING PATH IN A COMMUNICATION NETWORK"**

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

As a Preliminary Amendment for entry into the National Stage for the above-identified PCT application, the following is submitted:

IN THE ABSTRACT:

Please rewrite the Abstract to read as follows:

--**ABSTRACT OF THE DISCLOSURE**

In a method for determining a suitable connecting path in a communication network as well as to a corresponding switching equipment, given the presence of a connection inquiry to a requested destination node, a check is first carried out to see whether a suitable connecting path to the requested destination node is already stored in a corresponding dynamic memory. When this is not the case, a suitable connecting path is determined on the basis of stored network data of the communication network and is subsequently entered in the dynamic memory, so that this connecting path is subsequently available for further connecting path determinations. After determining a suitable connecting path, the connection to the requested destination node is set up according to the determined connecting path.--

IN THE DRAWINGS:

Please amend the drawings as indicated in the attached Submission of Corrected Drawings.

IN THE SPECIFICATION:

Please amend the substitute specification as follows (all references are to the substitute pages):

On page 1, before the title, insert

--S P E C I F I C A T I O N

TITLE--;

after the title, as a separate line, insert

--**BACKGROUND OF THE INVENTION**--.

On page 1, at line 8, after "As" insert --is--, delete "or" and substitute --of--.

On page 1, at line 14, delete "[sic]".

On page 2, at line 20, before "transfer" insert --a--.

On page 2, second to the last line, delete ", respectively".

On page 3, at line 3, delete "ensues".

On page 3, at line 6, before "known" insert --is--, delete ",respectively".

On page 3, at line 9, delete ",respectively".

On page 3, at line 21, delete ",respectively".

On page 4, at line 1, delete "[sic]".

On page 4, at line 9, delete ",respectively".

On page 4, at line 21, delete ",respectively".

On page 4, at line 23, delete "To this end", and substitute --For this purpose--.

On page 5, at line 20, before "current" insert --a--.

On page 5, at line 25, delete "species" and substitute --type--.

On page 5, before line 26, insert the following title:

--**<u>SUMMARY OF THE INVENTION</u>**--.

On page 5, delete "The" and substitute --It is an object of the--.

On page 5, at line 26, delete "is therefore based on the object of creating an" and substitute --to create an--.

On page 5, second to the last line, delete "an".

On page 6, delete "this object is achieved by a method", and substitute the following:

--a method is provided for determining a connecting path in a communication network. In a first step, it is determined whether a suitable connecting path to a requested destination node of the communication network is already stored. In a second step, when in the first step a suitable stored connecting path has not yet been identified, determining a suitable connecting path to the requested destination node on the basis of stored network data that describe the communication network, and storing the connecting path so that it is available for a new determination of a connecting path in the first step. In a third step, communicating path information corresponding to the connecting path determined in the first or second steps to network nodes that are a component part of the determined connecting path in order to set up the determined connecting path to the requested destination node.--

On page 6, delete lines 2-5.

On page 8, delete line 5, and insert the following heading:

--**BRIEF DESCRIPTION OF THE DRAWINGS**--

On page 8, at line 6, after "Figure 1" insert --is--.

On page 8, at line 7, delete "inventive", after "equipment" insert --of the invention; and--.

On page 8, at line 8, after "Figure 2", insert --is--.

On page 8, at line 9, delete "inventive", after "equipment" insert --of the invention--.

On page 8, at line 10, after "3b" insert --show--.

On page 8, after line 10, and before line 11, insert the following heading:

--**DESCRIPTION OF THE PREFERRED EMBODIMENTS**--.

On page 8, at line 17, delete "or means".

On page 8, at line 20, delete "means" and substitute --device--.

On page 8, at line 21, delete "means" and substitute --device--.

On page 8, at line 23, delete "fashioned" and substitute --designed--.

On page 8, at line 25, delete "coupling means" and substitute --switching device 3--.

On page 8, at the last line, delete "means" and substitute --device--.

On page 10, at line 19, delete "comprise [sic]" and substitute --comprises--.

On page 10, at the last line, delete "ensues" and substitute --occurs--.

On page 11, at line 3, delete "ensue" and substitute --occur--.

On page 14, as the last paragraph, insert the following paragraph:

--Although various minor changes and modifications might be proposed by those skilled in the art, it will be understood that my wish is to include within the claims of the patent warranted hereon all such changes and

modifications as reasonably come within my contribution to the art.--

IN THE CLAIMS:

On page 15 of the claims, line 1, please change "Patent Claims" to --**I CLAIM AS MY INVENTION**--.

Please cancel claims 1-17 without prejudice.

Please add new claims 18-34 as follows:

18. A method for determining a connecting path in a communication network, comprising the steps of:

in a first step, determining whether a suitable connecting path to a requested destination node of the communication network is already stored;

when, in the first step, a suitable, stored connecting path has not yet been identified, in a second step determining a suitable connecting path to the requested destination node on the basis of stored network data that describe the communication network, and storing the connecting path, so that it is available for a new determination of a connecting path in the first step; and

in a third step, communicating path information corresponding to the connecting path determined in the first or second steps to network nodes that are a component part of the determined connecting path in order to set up the determined connecting path to the requested destination node.

19. A method according to claim 18 wherein a connecting path to the requested destination node is considered as a suitable connecting path in the first or

the second step when the corresponding connecting path leads from an originating node of the communication network to the requested destination node and specific transmission properties for a data transmission to the destination node are met.

20. The method according to claim 18 wherein a plurality of standard connecting paths to specific network nodes of the communication network are permanently stored in advance, these being checked in the first step together with the connecting path previously determined and stored according to the second step.

21. The method according to claim 18 wherein only a specific, maximum plurality of determined connecting paths are stored in the second step.

22. The method according to claim 21 wherein given determination of a new, suitable connecting path in the second step, the connecting path previously stored longest according to the second step is erased when a plurality of connecting paths that corresponds to the maximum plurality has already been previously determined and stored according to the second step.

23. The method according to claim 21 wherein given determination of a new, suitable connecting path in the second step, the connecting path previously stored according to the second step and used least according to the third step is erased when a plurality of connecting

paths that corresponds to the maximum plurality has already been previously determined and stored according to the second step.

24. The method according to claim 21 wherein the maximum plurality of the connecting paths that can be stored according to the second step is variable.

25. The method according to claim 24 wherein the plurality of overflow cases is counted wherein a new connecting path has been determined according to the second step and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality has already been previously determined and stored according to the second step; and in that the maximum plurality of connecting paths that can be stored according to the second step is set dependent on the number of overflow cases.

26. The method according to claim 24 wherein when a new connecting path has been determined according to the second step and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality has already been previously determined and stored according to the second step, the maximum plurality of connecting paths that can be stored according to the second step is raised for a specific time span and is in turn reset after the expiration of the specific time span.

27. The method according to claim 18 wherein the first through third steps are automatically implemented by a control unit in a switching equipment that forms a network node of the communication network.

28. A switching equipment for determining a connecting path in a communication network, comprising:

a plurality of line units respectively connected to at least one terminal equipment or to at least one further switching equipment;

a first memory for storing network data that describe the communication network;

a second memory for storing connecting paths that connect the switching equipment to specific destination switching equipment of the communication network;

a control unit that, upon reception of a connection inquiry via one of the line units for a connection to a requested destination switching equipment of the communication network, searches the second memory for a suitable connecting path to the requested destination switching equipment and, when it does not find a suitable connecting path in the second memory, determines a suitable connecting path to the requested destination switching equipment on the basis of the network data stored in the first memory and stores it in the second memory;

the control unit, after determining a suitable connecting path stored in the second memory or determining a suitable connecting path based on the network data stored in the first memory, communicates

path information corresponding to the suitable connecting path via a corresponding line unit to further switching equipment that are a component part of the suitable connecting path to the requested destination switching equipment in order to set up the connecting path to the requested destination switching equipment.

29. The switching equipment according to claim 28 wherein a third memory is provided in which a plurality of standard connecting paths to specific destination switching equipment of the communication network are permanently stored,
as a result of a connection inquiry for a connection to a requested destination switching equipment, the control unit searches the third memory together with the second memory for a suitable connecting path to the requested destination switching equipment.

30. The switching equipment according to claim 28 wherein the control unit monitors the plurality of connecting paths stored in the second memory with respect to a specific, maximum plurality.

31. The switching equipment according to claim 30 wherein after determining a new, suitable connecting path on the basis of the network data stored in the first memory, the control unit erases the connecting path previously stored longest in the second memory in case the control unit finds that a plurality of connecting

paths corresponding to the maximum plurality has already been stored in the second memory.

32. The switching equipment according to claim 30 wherein a counting unit for counting a frequency of employment of each connecting path stored in the second memory for a connection setup to a respectively requested destination switching equipment of the communication network,
whereby, after determining a new, suitable connecting path on the basis of the network data stored in the first memory, the control unit erases the connecting path previously stored in the second memory that is employed least in case the control unit finds that a plurality of connecting paths corresponding to the maximum plurality has already been stored in the second memory.

33. The switching equipment according to claim 30 including a counting unit for counting overflow cases of the second memory wherein, after determining a new connecting path on the basis of the network data stored in the first memory, this is to be stored in the second memory even though a plurality of connecting paths corresponding to the maximum plurality has already been previously stored in the second memory,
whereby the control unit sets the maximum plurality of connecting paths stored in the second memory dependent on the acquired plurality of overflow cases.

34. The switching equipment according to claim 30 wherein after determining a new connecting path on the basis of the network data stored in the first memory and before storing the determined connecting path in the second memory, the control unit temporarily increases the maximum plurality of connecting paths that can be stored in the second memory when the control unit finds that a plurality of connecting paths corresponding to the maximum plurality has already been previously stored in the second memory.

REMARKS

The specification, drawings, and abstract have been amended in accordance with U. S. practice, and for improved readability and clarity.

Also, new claims drawn in accordance with U.S. practice, but based on the PCT prosecuted claims are also submitted herewith.

An Information Disclosure Statement is enclosed for the Examiner's review.

Respectfully submitted,

(Reg.No. 27,841)
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09/582120

Siemens AG
New PCT application
Our Case P-00,1291
1998P01063WOUS
Inventor: Liebl
Re: Substitute Pages

Translation / June 15, 2000 / 911.911 / 6200 words

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METHOD AND DETERMINATION DEVICE FOR THE IMPLEMENTATION OF THE METHOD FOR DETERMINING A CONNECTING PATH IN A COMMUNICATION NETWORK

The present invention is directed to a method for determining a connecting path in a communication network as well as to a corresponding switching equipment for use in communication networks, particularly in communication networks having hierarchically complete determination of connecting paths.

As known, communication networks are composed of a plurality or network or switching nodes that are connected to one another according to a specific network topology. Subscriber terminal equipment can be connected to some of these network nodes as user-specific line units of a communication network, whereas other network nodes serve only as transfer nodes, i.e. for forwarding communication information.

By way of example, Figure 3a shows the structure of a binary-like [sic] communication network structure. According to Figure 3a, the communication network shown by way of example comprises a total of ten network nodes K_1 - K_{10}. A plurality of subscriber terminal equipment EG_{11} - EG_{43} are respectively connected to the network nodes K_1 - K_4. These network nodes K_1 - K_4 form the lowest hierarchy level of the communication network shown in Figure 3a and are referred to as local network nodes. The local network nodes K_1 - K_4 are connected to one another with corresponding connecting paths via the other network nodes K_5 - K_{10}. According to the example shown in Figure 3a, no subscriber terminal equipment are connected to the network nodes K_5 - K_{10}, so that these network nodes serve only as transfer or switching nodes. The network nodes K_5 - K_7 correspond to regional network nodes and serve the purpose of connecting the local network nodes K_1 and K_2, K_2 and K_3 or, respectively, K_3 and K_4. Correspondingly, the network nodes K_8 and K_9 serve for connecting the regional network nodes K_5 and K_6 or, respectively, K_6 and K_7 and are referred to as super-regional network nodes. Finally, the node central K_{10} that

connects the super-regional network nodes K_8 and K_9 to one another forms the highest hierarchy level of the communication system shown in Figure 3a. When, for example, the subscriber EG_{42} is called from the subscriber terminal equipment EG_{12}, a connecting path or, respectively, connecting route must be set up via the communication network proceeding from the local network node K_1 to the local destination network node K_4 of the called subscriber. There are thereby a number of connecting possibilities according to the communication network shown in Figure 3a. One connection, for example, could lead via the network nodes K_1 - K_5 - K_8 - K_{10} - K_9 - K_7 - K_4. Another connecting possibility would be the connecting path via the [...] K_1 - K_5 - K_2 - K_6 - K_3 - K_7 - K_4, etc. The individual network nodes K_1 - K_{10} are formed by switching equipment whose jobs include determining the suitable connecting path from a calling terminal equipment to a called terminal equipment and setting up the corresponding connection.

Whereas Figure 3a shows a tree-like communication network structure, Figure 3b shows a cube-like communication network structure, whereby, in particular, respectively three network nodes K_1 - K_3 form a network node group that is connected via corresponding connecting lines to a neighboring network node group that is likewise composed of three network nodes. Terminal equipment can be optionally connected to each of the network nodes shown in Figure 3b or the corresponding network node can merely serve as transfer node without terminal equipment connected thereto.

Due to the currently increasing need for digital communication networks with great bandwidths and high transmission rates, what is referred to as the ATM transmission principle (asynchronous transfer mode) has prevailed for data transmission in communication networks. According to this ATM transmission principle, the data to be transmitted are communicated in the form of what are referred to as ATM cells that are composed of a header and an information field. The header contains address or, respectively, control information of the corresponding ATM cell, whereas the information field comprises the actual payload information. The address

information contained in the header are employed for the routing of the payload information within the communication network. The data transmission from one network node to another ensues optically, i.e. via light waveguides.

In communication networks having hierarchically complete path determination, the network topology of the communication network is stored and, thus, known in the individual network nodes. Each network node or, respectively, the corresponding switching equipment of this network node is thus informed, for example, about how many and which other network nodes are present in the communication network, which connecting lines or, respectively, connecting paths exist between the individual network nodes and what transmission properties (for example, transmission capacities and transmission statusses) the corresponding connecting paths have. On principle, thus, every network node is in the position to determine a hierarchically complete connecting path to a desired destination node of the communication network. As a rule, the complete connecting path is defined by that network node to which the calling terminal equipment is connected (see the network nodes K_1 - K_4 in Figure 3a). After receiving the corresponding connection request (for example, to the terminal equipment EG_{42} shown in Figure 3a), the originating node determines the entire path through the communication network up to the desired destination node on the basis of the information about the communication network available to it. After defining the suitable connecting path, the originating node or, respectively, the switching equipment thereof generates an information element in which the individual network nodes to be traversed along the defined connecting path are defined. Additionally, the connecting lines (ports) can also already be defined in the information element. Together with a pointer, this information element is communicated to the individual network nodes participating in the defined connecting path, whereby the pointer respectively points to the next network node to be approached. When, for example, a connection is requested from the terminal equipment EG_{12} shown in Figure 3a to the terminal equipment EG_{42} and when the originating node K_1 has selected the route K_1 - K_5 - K_2 - K_6 - K_3 - K_7 - K_7

[sic] - K_4 for this connection, the individual network nodes K_5, K_2, K_6, K_3, K_7 and K_4 to be approached are successively deposited in the corresponding information element in the form of a stack memory, whereby the pointer of the information element points first to the network node K_5.

In order to keep the connection setup times relatively short, the connecting paths to every potential destination node of the communication network are determined in advance and stored in the individual network nodes. Due to the different quality demands (for example, bandwidth, delay, etc.) of a connection request or, respectively, of a connection inquiry and due to the increasing complexity of the communication networks, all possible connecting paths from an originating node to a destination node can usually not be calculated in advance and stored. First, there is thereby the risk of inadequate memory space; second, not all possible alternative paths are in fact usually made use of. Further, the time required for a connection setup lengthens if all possible alternative paths must be searched before the actual connection setup before the ultimately suited connecting path was capable of being found. When, on the other hand, all of the pre-calculated connecting paths fail to satisfy the demands of a connection request (for example, with respect to the bandwidth or transmission rate), a suitable connecting path must first be newly determined on the basis of the available network information. This can be a very time-intensive procedure dependent on the complexity of the communication network, as a result whereof the connection setup can be substantially delayed or, respectively, even jeopardized. As a compromise, only a specific plurality of standard connecting paths are therefore stored in each network node. To this end, standard values are assumed for the individual connecting paths to each network node of the communication network with respect to the quality demands of the corresponding connection request, and, for example, only the respectively shortest path or paths to each potential destination node is/are calculated and stored. Given a pending connection request, all pre-calculated and stored connecting paths are then checked to see whether they meet the quality demands of the pending connection request. When

one of the pre-calculated connecting paths meets the quality demands, this is employed for the connection setup to the requested destination node. When, however, none of the pre-calculated connecting paths meets the corresponding quality demands, a suitable alternative path to the requested destination node is determined on the basis of the stored network topology data and employed for the connection setup.

However, the above-described procedure has the disadvantage that, dependent on the pending connection request, it is still not possible to preclude relatively long connection setup times since only a relatively slight number of standard connecting paths is pre-calculated and stored, so that a suitable alternative path must potentially be determined first when none of these pre-calculated standard connecting paths can meet the quality demands of a requested connection, which can in part be very time-intensive dependent on the complexity of the communication network.

Further, United States Letters Patent US-A-4,862,496 discloses a method for traffic routing in a line-switching communication network, particularly upon setup of a connection between neighboring switching nodes, that selects a second path on the basis of further connecting paths predetermined in the respective switching nodes, whereby, given the occurrence of an overload on the preferred connecting path, the connection to be switched is discarded and one of the predetermined, further connecting paths is selected as current alternate connecting path. When, for example, the direct path between a first network node and a neighboring, second network node that is provided for the connection setup is overloaded, then the connection can be set up via the current alternate connecting path prescribed in the first network node. Such traffic routing methods for line-switching communication networks are assigned to the species of "hop-by-hop routing" methods in the technical field.

The present invention is therefore based on the object of creating an improved method for determining a connecting path in a communication network as well as a ch switching equipment for a communication network, whereby the time required for setting up a requested connection can be shortened.

According to the present invention, this object is achieved by a method comprising the features of claim 1 as well as a switching equipment comprising the features of claim 11. The subclaims describe advantageous developments of the present invention that in turn contribute to a further shortening of the connection setup times or, respectively, to assuring the determination of a suitable connecting path.

According to the present invention, a dynamic connecting path memory is established. When a connection request or, respectively, a connection inquiry pends, this connecting path memory is searched for a suitable connecting path to the requested destination node. When the stored connecting paths do not meet the demands of the connection request, a suitable alternative path to the requested destination node is determined on the basis of the stored network topology data and entered into the dynamic connecting path memory, whereby the connecting paths deposited in the dynamic connecting path memory remain stored in the corresponding switching equipment beyond the duration of the connection.

This dynamic connecting path memory can be alternatively or additionally present to the initially described memory with pre-calculated, standard connecting paths. When the dynamic connecting path memory is present in addition to the memory with pre-calculated, standard connecting paths, the memory with pre-calculated, standard connecting paths is searched first upon arrival of a connection inquiry for a suitable connecting path to the requested destination node that also meets the demands of the connection request. When all pre-calculated, standard connecting paths are unsuitable for the pending connection request, the connecting paths stored in the dynamic connecting path memory are searched in the next step. When, at this time, there is still no entry in the dynamic connecting path memory or, respectively, a suitable connecting path that meets the demands of the connection request is also not deposited in the dynamic connecting path memory, a suitable alternative path is determined on the basis of the stored network topologies and is entered into the dynamic connecting path memory. This connecting path is subsequently employed for the connection setup.

The dynamic connecting path memory can comprise a predetermined, maximum plurality of destination node-specific memory locations. When a new connecting path is to be entered in the dynamic connecting path memory and when all n memory locations are already occupied, the connecting path situated longest in the dynamic connecting path memory can, for example, be overwritten. It is likewise possible to overwrite the connecting path that is employed least often. When a connecting path stored in the dynamic connecting path memory is eliminated or, respectively, when this becomes invalid, for example because sub-paths or network nodes that are employed are down, the corresponding connecting path is removed from the dynamic path memory, i.e. erased.

The maximum plurality n of memory locations of the dynamic connecting path memory can be permanently prescribed or can be adjustable. It is advantageous to acquire the plurality of "overflows" per defined time unit of the dynamic connecting path memory and to increase the maximum plurality of memory locations of the dynamic connecting path memory dependent thereon. After expiration of a specific time span, the maximum plurality of available memory locations can in turn be reset after an incrementation, using a timer control.

A self-optimizing connecting path table is established in the corresponding network node, i.e. the corresponding switching equipment, of the communication network as a result of the inventively proposed employment of a dynamic path memory. It is assured in this way that the memory resources are protected against connecting paths that are only rarely or never employed. Further, it is only necessary to calculate a few or, respectively, absolutely no pre-calculated, standard connecting paths. The connection setup times are shortened on average due to the employment of the dynamic connecting path memory since, as a result of the dynamic connecting path memory, the probability increases substantially that a connecting path that is already suitable is available for an incoming connection request.

The present invention can be applied both to broadband networks as well as to narrowband networks and is independent of the communication standard respectively employed for the data transmission.

The invention is described in greater detail below on the basis of preferred exemplary embodiments with reference to the attached drawing. Shown are:

Figure 1 a schematic block circuit diagram of the structure of a first exemplary embodiment of the inventive switching equipment;

Figure 2 a schematic block circuit diagram of the structure of a second exemplary embodiment of the inventive switching equipment; and

Figures 3a and 3b exemplary communication network structures.

Figure 1 shows a switching equipment 1 that is a component part of every network node of a communication network that, for example, can be structured as in Figures 3a or 3b. The switching equipment 1 comprises a plurality of line units 2 that are respectively connected to a subscriber terminal equipment or to another switching equipment of another network node. The line units 2 convert the incoming information into digital data words to be internally processed. Further, the switching equipment 1 comprises a switching device or means 3 that serves the purpose of producing a physical connection between the individual line units 2 of the switching equipment for the transmission of data between the paths connected to the corresponding line units 2. The switching means 3 comprises a plurality of individual switching elements that form a switching network. The switching means 3 is the actual switching location of the switching equipment 1. Further, the switching equipment 1 comprises a control unit 4 fashioned, for example, in the form of a microprocessor that forms the heart of the switching equipment 1 and serves for the drive and monitoring of the individual line units 2 as well as of the coupling means 3. Among other things, the control unit 4 sees to the synchronization of the individual line units 2 to the internal clock of the switching equipment 1 and for defining the physical connections between the individual line units 2 that are to be realized by the switching means 3. The control unit 4 thus determines via which path or,

respectively, via which line unit 2 the communication data received via a different line unit 2 are to be forwarded or, respectively, output.

Further, the switching equipment 1 shown in Figure 1 comprises a first memory 7 in which the data of the network topology of the corresponding communication network are comprehensively stored. Particularly stored in this first memory 7 are how many and which other network nodes the communication network comprises, which connecting lines or, respectively, connecting paths exist between the individual network nodes and what transmission properties (such as, for example, transmission capacities or transmission statusses) these transmission paths comprise, etc.

The pre-calculated, standard connecting paths to the individual, potential destination nodes of the communication network that have already been explained above are stored in a second memory 6. As has already been explained, it is known from the Prior Art to pre-calculate specific, standard connecting paths to the individual, potential destination nodes of the communication network, whereby these standard connecting paths can, for example, respectively represent the shortest connecting path from the switching equipment 1 to another potential destination node of the communication network. Specific, standard connecting paths as well as the corresponding connection parameters or, respectively, connection properties (such as, for example, transmission capacity or transmission status) are thus stored in the second memory 6 in destination node-specific fashion. However, it is not absolutely necessary to store the connection parameters for every connecting path in the second memory 6 since, in principle, these information are already deposited in the first memory 7. In order, however, to keep the connection setup times as short as possible, it is advantageous to deposit the corresponding connection parameters or, respectively, connection properties at the same time for each connecting path deposited in the second memory 6. It is assumed in the exemplary embodiment shown in Figure 1, that, in addition to comprising the switching equipment 1, the corresponding communication network comprises a further N, other switching

equipment that serve as potential destination nodes for a communication connection with the switching equipment 1. One or more standard connecting paths can be stored for each potential destination node.

The switching equipment 1 also comprises a third memory 5 that serves as dynamic connecting path memory. The memory 5 is initially empty at the initial commissioning of the switching equipment 1.

The function of the switching equipment shown in Figure 1 or, respectively, the control unit 4 thereof is as follows.

When a connection inquiry or, respectively, a connection request is received via one of the line units 2, the control unit 4 must first determine a suitable connecting path to the requested destination node before the setup of the corresponding connection, whereby, in particular, the connecting path must do justice to quality demands made of the requested connection (for example, bandwidth, transmission rate, etc.) that are potentially prescribed in user-specific fashion. To this end, the control unit 4 initially searches the standard connecting paths to the desired destination node that are stored in the second memory 6. On the basis of the connection properties of the corresponding, standard connecting paths to the requested destination node that are likewise deposited in the second memory 6, the control unit 4 can determine whether the second memory 6 comprise [sic] a connecting path to the requested destination node that is suited for the requested connection properties. When this is the case, the corresponding connecting path is read out from the second memory 6 and employed for the connection setup. When, however, the control unit 4 has not found a suitable connecting path to the requested destination node in the second memory 6, the control unit 4 (with reference to the network topology data stored in the first, network topology memory 7) determines a suitable connecting path to the requested destination node that, in particular, meets the quality demands of the connection request.

Subsequently, this alternative path determined by the control unit 4 is entered in the third, dynamic connecting path memory 5. The entry ensues

destination node-specifically and can, as shown in Figure 1, also comprise the connection parameters or, respectively, transmission properties of the corresponding, identified connecting path. The entries in the third, dynamic memory 5 thereby ensue in the sequence of the determination of the corresponding connecting paths by the control unit 4. Advantageously, the determined connecting paths are therefore stored in the third memory 5 in the form of an FIFO stack. As can be derived from Figure 1, the third, dynamic memory 5 is not limited to one entry per potential destination node; rather, a plurality of connecting paths (potentially with different transmission properties) can be entered for each destination node. After entry of a connecting path in the third memory 5, the corresponding connecting path determined by the control unit 4 is employed for the connection setup to the requested destination node. The entries in the third memory 5 also remain stored in the third memory 5 beyond the connection duration of the respectively corresponding connecting path.

When further connection requests are subsequently received at the switching equipment 1, the control unit 4 searches not only the pre-calculated, standard connecting paths to the requested destination node that are stored in the second memory 6 but also searches the entries deposited in the third, dynamic memory 5. Only when suitable connecting paths to the requested destination node are found neither in the second memory 6 nor in the third, dynamic memory 5 does the control unit 4 again determine a suitable connecting path on the basis of the network topology data stored in the second memory 6 and subsequently enter this in the third memory 5.

The scope of the third memory 5 can be either permanently prescribed or variable. Before entry of a newly determined connecting path into the third memory 5, the control unit 4 regularly monitors the memory occupation of the third memory 5. When a newly determined connecting path is to be entered into the third memory 5 even though a maximum plurality n of memory locations is already occupied, the control unit according to the first exemplary embodiment shown in Figure 1 overwrites the connecting path that has been stored longest in the third memory 5.

When a connecting path has become invalid in the interim, for example because sub-paths or network nodes that are used have failed, this connecting path is potentially removed both from the memory 6 as well as from the third memory 5.

The connection setup times can be shortened on average by employing the third, dynamic memory 5, since the probability increases substantially that a suitable connecting path is available either in the second memory 6 or in the third memory 5. In particular, the third memory 5 contains only entries of connecting paths that have already met certain quality demands of a corresponding connection request. The entries of the third memory 5 are thus higher in quality compared to the entries of the second memory 6 and therefore contribute to the shortening of the connection setup times since they clearly enhance the probability of finding a suitable connecting path.

After the control unit 4 of the switching equipment 1 -- as described above -- has determined a suitable connecting path to the requested destination node, the control unit 4 generates the aforementioned information element in which the individual network nodes of the communication network that are to be traversed according to the determined connecting path are deposited. This information element is communicated from the control unit 4 via a corresponding line unit 2 to the first network node of this connecting path and comprises a pointer that always points to the next network node to be approached in the communication network. The network node of the communication network that is approached first thus forwards the pointer to a network node after reception of this information element.

Of course, the switching equipment 1 shown in Figure 1 can also be employed without the second memory 6 with the pre-calculated and stored, standard connecting paths to the individual, potential destination nodes of the communication network. In this case, the control unit 4 searches only the entries of the third memory 5 upon arrival of a connection inquiry and determines a suitable connecting path on the basis of the network topology data stored in the first memory 7 if the third memory 5 has no suitable connecting path entries. Subsequently, the newly

determined connecting path is deposited in the third memory 5 and is then available for the determination of a new connecting path.

It has already been explained with reference to the second memory 6 that the storing of the connection parameters of the corresponding connecting path in the second memory 6 is optional. This also applies to the entries in the third memory 5. With respect to the third memory 5, too, it is fundamentally adequate when only the determined connecting path to the corresponding destination node is stored, since the transmission properties or, respectively, connection parameters corresponding to the connecting path are stored in the first memory 7. The storing of the connection parameters together with the corresponding connecting path in the third memory 5, however, is advantageous since the control unit 4 need not additionally access the entries in the first memory 7 subsequently in the determination of a new connecting path in order to identify the corresponding transmission properties of the respective connecting path.

Figure 2 shows a second exemplary embodiment of the inventive switching equipment.

The switching equipment 1 shown in Figure 2 as well as the function thereof essentially corresponds to the switching equipment shown in Figure 1. According to the second exemplary embodiment, however, the switching equipment 1 also comprises an overflow counter 8. This overflow counter 8 acquires the plurality of overflows of the third, dynamic connecting path memory 5. I.e., the counter reading of the overflow counter 8 is always incremented by 1 when the control unit 4 wishes to enter a new connecting path in the third memory 5 even though a number of connecting paths corresponding to the predetermined maximum plurality n is already stored. The control unit can determine the number of "overflows" of the third memory 5 during a defined time span on the basis of the counter reading of the overflow counter 8 and can correspondingly adapt the memory scope of the third memory 5 dependent thereon, i.e. raise or lower the maximum plurality n of the entries of the third memory 5. When the maximum plurality n of entries of the third

memory 5 was raised or lowered, the control unit 4 in a version of the second exemplary embodiment shown in Figure 2 can in turn reset the maximum memory scope n of the third memory 5 to the original value after the expiration of a corresponding time span.

Another characteristic of the exemplary embodiment shown in Figure 2 is the fact that, in addition to the data shown in Figure 1, the control unit 4 also stores the frequency of use of each connecting path deposited in the third memory 5. This means that, given employment of a connecting path stored in the third memory 5, the control unit likewise increments the counter of this connecting path stored in the third memory 5 by 1. This version makes it possible for the control unit 4 to overwrite the least frequently employed connecting path of the third memory 5 with a newly determined connecting path when the maximum plurality n of memory locations of the third memory 5 is already occupied.

Particularly as a result of monitoring the frequency of use of each connecting path deposited in the third memory 5, the third memory 5 forms a self-optimizing connecting path table. The quality of the entries of the third memory 5 increases with the operating duration of the switching equipment 1 or, respectively, with the plurality of connections requests arriving at the switching equipment. This self-optimizing connecting path table assures that connecting paths that are only used seldom or not at all do not remain stored in the third, dynamic memory 5 over a longer time.

By employing the third, dynamic memory 5, i.e. a memory whose content dynamically changes with the operating duration of the switching equipment, only a few or, respectively, potentially absolutely no standard connecting paths need be calculated in advance and stored (in the second memory 6).

Patent Claims

1. Method for determining a connecting path in a communication network, comprising the steps:

a) determining whether a suitable connecting path to a requested destination node of the communication network is already stored;

b) when, in step a), a suitable, stored connecting path has not yet been identified, determining a suitable connecting path to the requested destination node on the basis of stored network data that describe the communication network, and storing the connecting path, so that this is available for a new determination of a connecting path in step a); and

c) communicating path information corresponding to the connecting path determined in step a) or b) to network nodes that are a component part of the determined connecting path in order to set up the determined connecting path to the requested destination node.

2. Method according to claim 1, characterized in that a connecting path to the requested destination node is considered as suitable connecting path in step a) or b) when the corresponding connecting path leads from an originating node of the communication network to the requested destination node and specific transmission properties for a data transmission to the destination node are met.

3. Method according to claim 1 or 2, characterized in that a plurality of standard connecting paths to specific network nodes of the communication network are permanently stored in advance, these being checked in step a) together with connecting path previously determined and stored according to step b).

4. Method according to one of the preceding claims, characterized in that only a specific, maximum plurality (n) of determined connecting paths are stored in step b).

5. Method according to claim 4, characterized in that, given determination of a new, suitable connecting path in step b), the connecting path previously stored longest according to step b) is erased when a plurality of connecting paths that

corresponds to the maximum plurality (n) has already been previously determined and stored according to step b).

6. Method according to claim 4, characterized in that, given determination of a new, suitable connecting path in step b), the connecting path previously stored according to step b) and used least according to step c) is erased when a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b).

7. Method according to one of the claims 4-6, characterized in that the maximum plurality (n) of the connecting paths that can be stored according to step b) is variable.

8. Method according to claim 7, characterized in that the plurality of overflow cases is counted wherein a new connecting path has been determined according to step b) and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b); and in that the maximum plurality (n) of connecting paths that can be stored according to step b) is set dependent on the number of overflow cases.

9. Method according to claim 7 or 8, characterized in that, when a new connecting path has been determined according to step b) and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b), the maximum plurality (n) of connecting paths that can be stored according to step b) is raised for a specific time span and is in turn reset after the expiration of the specific time span.

10. Method according to one of the preceding claims, characterized in that the steps a) - c) are automatically implemented by a control unit (4) in a switching equipment (1) that forms a network node (K_1 - K_{10}) of the communication network.

11. Switching equipment (1) for the implementation of the method for determining a connecting path in a communication network,

comprising a plurality of line units (2) that are respectively connected to at least one terminal equipment (EG_{11} - EG_{43}) or to at least one further switching equipment, comprising first memory (7) for storing network data that describe the communication network;

comprising second memory (5) for storing connecting paths that connect the switching equipment (1) to specific destination switching equipment of the communication network; and

comprising a control unit (4) that, upon reception of a connection inquiry via one of the line units (2) for a connection to a requested destination switching equipment of the communication network, search the second memory (5) for a suitable connecting path to the requested destination switching equipment and, when it does not find a suitable connecting path in the second memory (5), determines a suitable connecting path to the requested destination switching equipment on the basis of the network data stored in the first memory and stores it in the second memory (5),

whereby the control unit (4), after determining a suitable connecting path stored in the second memory (5) or determining a suitable connecting path on the basis of the network data stored in the first memory (7), communicates path information corresponding to the suitable connecting path via a corresponding line unit (2) to further switching equipment that are a component part of the suitable connecting path to the requested destination switching equipment in order to set up the connecting path to the requested destination switching equipment.

12. Switching equipment according to claim 11, characterized by a third memory (6) wherein a plurality of standard connecting paths to specific destination switching equipment of the communication network are permanently stored,

whereby, as a result of a connection inquiry for a connection to a requested destination switching equipment, the control unit (4) searches the third memory (6) together with the second memory (5) for a suitable connecting path to the requested destination switching equipment.

13. Switching equipment according to claim 11 or 12, characterized in that the control unit (4) monitors the plurality of connecting paths stored in the second memory (5) with respect to a specific, maximum plurality (n).

14. Switching equipment according to claim 13, characterized in that, after determining a new, suitable connecting path on the basis of the network data stored in the first memory (7), the control unit (4) erases the connecting path previously stored longest in the second memory (5) in case the control unit (4) finds that a plurality of connecting paths corresponding to the maximum plurality (n) has already been stored in the second memory (5).

15. Switching equipment according to claim 13, characterized by counting means for counting the frequency of employment of each connecting path stored in the second memory (5) for a connection setup to a respectively requested destination switching equipment of the communication network,
whereby, after determining a new, suitable connecting path on the basis of the network data stored in the first memory (7), the control unit (4) erases the connecting path previously stored in the second memory (5) that is employed least in case the control unit (4) finds that a plurality of connecting paths corresponding to the maximum plurality (n) has already been stored in the second memory (5).

16. Switching equipment according to one of the claims 13 - 15, characterized by
counting means (8) for counting the overflow cases of the second memory (5) wherein, after determining a new connecting path on the basis of the network data stored in the first memory (7), this is to be stored in the second memory (5) even though a plurality of connecting paths corresponding to the maximum plurality (n) has already been previously stored in the second memory (5),
whereby the control unit (4) sets the maximum plurality (n) of connecting paths stored in the second memory(5) dependent on the acquired plurality of overflow cases.

17. Switching equipment according to one of the claims 13 - 16, characterized in that,

after determining a new connecting path on the basis of the network data stored in the first memory(7) and before storing the determined connecting path in the second memory (5), the control unit (4) temporarily increases the maximum plurality (n) of connecting paths that can be stored in the second memory (5) when the control unit (4) finds that a plurality of connecting paths corresponding to the maximum plurality (n) has already been previously stored in the second memory (5).

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METHOD AND DETERMINATION DEVICE FOR DETERMINING A CONNECTING PATH IN A COMMUNICATION NETWORK

The present invention is directed to a method for determining a connecting path in a communication network as well as to a corresponding switching equipment for use in communication networks, particularly in communication networks having hierarchically complete determination of connecting paths.

As known, communication networks are composed of a plurality or network or switching nodes that are connected to one another according to a specific network topology. Subscriber terminal equipment can be connected to some of these network nodes as user-specific line units of a communication network, whereas other network nodes serve only as transfer nodes, i.e. for forwarding communication information.

By way of example, Figure 3a shows the structure of a binary-like [sic] communication network structure. According to Figure 3a, the communication network shown by way of example comprises a total of ten network nodes K_1 - K_{10}. A plurality of subscriber terminal equipment EG_{11} - EG_{43} are respectively connected to the network nodes K_1 - K_4. These network nodes K_1 - K_4 form the lowest hierarchy level of the communication network shown in Figure 3a and are referred to as local network nodes. The local network nodes K_1 - K_4 are connected to one another with corresponding connecting paths via the other network nodes K_5 - K_{10}. According to the example shown in Figure 3a, no subscriber terminal equipment are connected to the network nodes K_5 - K_{10}, so that these network nodes serve only as transfer or switching nodes. The network nodes K_5 - K_7 correspond to regional network nodes and serve the purpose of connecting the local network nodes K_1 and K_2, K_2 and K_3 or, respectively, K_3 and K_4. Correspondingly, the network nodes K_8 and K_9 serve for connecting the regional network nodes K_5 and K_6 or, respectively, K_6 and K_7 and are referred to as super-regional network nodes. Finally, the node central K_{10} that connects the super-regional network nodes K_8 and K_9 to one another forms the highest

hierarchy level of the communication system shown in Figure 3a. When, for example, the subscriber EG_{42} is called from the subscriber terminal equipment EG_{12}, a connecting path or, respectively, connecting route must be set up via the communication network proceeding from the local network node K_1 to the local destination network node K_4 of the called subscriber. There are thereby a number of connecting possibilities according to the communication network shown in Figure 3a. One connection, for example, could lead via the network nodes K_1 - K_5 - K_8 - K_{10} - K_9 - K_7 - K_4. Another connecting possibility would be the connecting path via the [...] K_1 - K_5 - K_2 - K_6 - K_3 - K_7 - K_4, etc. The individual network nodes K_1 - K_{10} are formed by switching equipment whose jobs include determining the suitable connecting path from a calling terminal equipment to a called terminal equipment and setting up the corresponding connection.

Whereas Figure 3a shows a tree-like communication network structure, Figure 3b shows a cube-like communication network structure, whereby, in particular, respectively three network nodes K_1 - K_3 form a network node group that is connected via corresponding connecting lines to a neighboring network node group that is likewise composed of three network nodes. Terminal equipment can be optionally connected to each of the network nodes shown in Figure 3b or the corresponding network node can merely serve as transfer node without terminal equipment connected thereto.

Due to the currently increasing need for digital communication networks with great bandwidths and high transmission rates, what is referred to as the ATM transmission principle (asynchronous transfer mode) has prevailed for data transmission in communication networks. According to this ATM transmission principle, the data to be transmitted are communicated in the form of what are referred to as ATM cells that are composed of a header and an information field. The header contains address or, respectively, control information of the corresponding ATM cell, whereas the information field comprises the actual payload information. The address information contained in the header are employed for the routing of the payload

information within the communication network. The data transmission from one network node to another ensues optically, i.e. via light waveguides.

In communication networks having hierarchically complete path determination, the network topology of the communication network is stored and, thus, known in the individual network nodes. Each network node or, respectively, the corresponding switching equipment of this network node is thus informed, for example, about how many and which other network nodes are present in the communication network, which connecting lines or, respectively, connecting paths exist between the individual network nodes and what transmission properties (for example, transmission capacities and transmission statusses) the corresponding connecting paths have. On principle, thus, every network node is in the position to determine a hierarchically complete connecting path to a desired destination node of the communication network. As a rule, the complete connecting path is defined by that network node to which the calling terminal equipment is connected (see the network nodes K_1 - K_4 in Figure 3a). After receiving the corresponding connection request (for example, to the terminal equipment EG_{42} shown in Figure 3a), the originating node determines the entire path through the communication network up to the desired destination node on the basis of the information about the communication network available to it. After defining the suitable connecting path, the originating node or, respectively, the switching equipment thereof generates an information element in which the individual network nodes to be traversed along the defined connecting path are defined. Additionally, the connecting lines (ports) can also already be defined in the information element. Together with a pointer, this information element is communicated to the individual network nodes participating in the defined connecting path, whereby the pointer respectively points to the next network node to be approached. When, for example, a connection is requested from the terminal equipment EG_{12} shown in Figure 3a to the terminal equipment EG_{42} and when the originating node K_1 has selected the route K_1 - K_5 - K_2 - K_6 - K_3 - K_7 - K_7 [sic] - K_4 for this connection, the individual network nodes K_5, K_2, K_6, K_3, K_7 and K_4

to be approached are successively deposited in the corresponding information element in the form of a stack memory, whereby the pointer of the information element points first to the network node K_5.

In order to keep the connection setup times relatively short, the connecting paths to every potential destination node of the communication network are determined in advance and stored in the individual network nodes. Due to the different quality demands (for example, bandwidth, delay, etc.) of a connection request or, respectively, of a connection inquiry and due to the increasing complexity of the communication networks, all possible connecting paths from an originating node to a destination node can usually not be calculated in advance and stored. First, there is thereby the risk of inadequate memory space; second, not all possible alternative paths are in fact usually made use of. Further, the time required for a connection setup lengthens if all possible alternative paths must be searched before the actual connection setup before the ultimately suited connecting path was capable of being found. When, on the other hand, all of the pre-calculated connecting paths fail to satisfy the demands of a connection request (for example, with respect to the bandwidth or transmission rate), a suitable connecting path must first be newly determined on the basis of the available network information. This can be a very time-intensive procedure dependent on the complexity of the communication network, as a result whereof the connection setup can be substantially delayed or, respectively, even jeopardized. As a compromise, only a specific plurality of standard connecting paths are therefore stored in each network node. To this end, standard values are assumed for the individual connecting paths to each network node of the communication network with respect to the quality demands of the corresponding connection request, and, for example, only the respectively shortest path or paths to each potential destination node is/are calculated and stored. Given a pending connection request, all pre-calculated and stored connecting paths are then checked to see whether they meet the quality demands of the pending connection request. When one of the pre-calculated connecting paths meets the quality demands, this is

employed for the connection setup to the requested destination node. When, however, none of the pre-calculated connecting paths meets the corresponding quality demands, a suitable alternative path to the requested destination node is determined on the basis of the stored network topology data and employed for the connection setup.

However, the above-described procedure has the disadvantage that, dependent on the pending connection request, it is still not possible to preclude relatively long connection setup times since only a relatively slight number of standard connecting paths is pre-calculated and stored, so that a suitable alternative path must potentially be determined first when none of these pre-calculated standard connecting paths can meet the quality demands of a requested connection, which can in part be very time-intensive dependent on the complexity of the communication network.

The present invention is therefore based on the object of creating an improved method for determining a connecting path in a communication network as well as a ch switching equipment for a communication network, whereby the time required for setting up a requested connection can be shortened.

According to the present invention, this object is achieved by a method comprising the features of claim 1 as well as a switching equipment comprising the features of claim 11. The subclaims describe advantageous developments of the present invention that in turn contribute to a further shortening of the connection setup times or, respectively, to assuring the determination of a suitable connecting path.

According to the present invention, a dynamic connecting path memory is established. When a connection request or, respectively, a connection inquiry pends, this connecting path memory is searched for a suitable connecting path to the requested destination node. When the stored connecting paths do not meet the demands of the connection request, a suitable alternative path to the requested destination node is determined on the basis of the stored network topology data and entered into the dynamic connecting path memory, whereby the connecting paths

deposited in the dynamic connecting path memory remain stored in the corresponding switching equipment beyond the duration of the connection.

This dynamic connecting path memory can be alternatively or additionally present to the initially described memory with pre-calculated, standard connecting paths. When the dynamic connecting path memory is present in addition to the memory with pre-calculated, standard connecting paths, the memory with pre-calculated, standard connecting paths is searched first upon arrival of a connection inquiry for a suitable connecting path to the requested destination node that also meets the demands of the connection request. When all pre-calculated, standard connecting paths are unsuitable for the pending connection request, the connecting paths stored in the dynamic connecting path memory are searched in the next step. When, at this time, there is still no entry in the dynamic connecting path memory or, respectively, a suitable connecting path that meets the demands of the connection request is also not deposited in the dynamic connecting path memory, a suitable alternative path is determined on the basis of the stored network topologies and is entered into the dynamic connecting path memory. This connecting path is subsequently employed for the connection setup.

The dynamic connecting path memory can comprise a predetermined, maximum plurality of destination node-specific memory locations. When a new connecting path is to be entered in the dynamic connecting path memory and when all n memory locations are already occupied, the connecting path situated longest in the dynamic connecting path memory can, for example, be overwritten. It is likewise possible to overwrite the connecting path that is employed least often. When a connecting path stored in the dynamic connecting path memory is eliminated or, respectively, when this becomes invalid, for example because sub-paths or network nodes that are employed are down, the corresponding connecting path is removed from the dynamic path memory, i.e. erased.

The maximum plurality n of memory locations of the dynamic connecting path memory can be permanently prescribed or can be adjustable. It is advantageous

to acquire the plurality of "overflows" per defined time unit of the dynamic connecting path memory and to increase the maximum plurality of memory locations of the dynamic connecting path memory dependent thereon. After expiration of a specific time span, the maximum plurality of available memory locations can in turn be reset after an incrementation, using a timer control.

A self-optimizing connecting path table is established in the corresponding network node, i.e. the corresponding switching equipment, of the communication network as a result of the inventively proposed employment of a dynamic path memory. It is assured in this way that the memory resources are protected against connecting paths that are only rarely or never employed. Further, it is only necessary to calculate a few or, respectively, absolutely no pre-calculated, standard connecting paths. The connection setup times are shortened on average due to the employment of the dynamic connecting path memory since, as a result of the dynamic connecting path memory, the probability increases substantially that a connecting path that is already suitable is available for an incoming connection request.

The present invention can be applied both to broadband networks as well as to narrowband networks and is independent of the communication standard respectively employed for the data transmission.

The invention is described in greater detail below on the basis of preferred exemplary embodiments with reference to the attached drawing. Shown are:

Figure 1	a schematic block circuit diagram of the structure of a first exemplary embodiment of the inventive switching equipment;
Figure 2	a schematic block circuit diagram of the structure of a second exemplary embodiment of the inventive switching equipment; and
Figures 3a and 3b	exemplary communication network structures.

Figure 1 shows a switching equipment 1 that is a component part of every network node of a communication network that, for example, can be structured as in Figures 3a or 3b. The switching equipment 1 comprises a plurality of line units 2 that are respectively connected to a subscriber terminal equipment or to another switching

equipment of another network node. The line units 2 convert the incoming information into digital data words to be internally processed. Further, the switching equipment 1 comprises a switching device or means 3 that serves the purpose of producing a physical connection between the individual line units 2 of the switching equipment for the transmission of data between the paths connected to the corresponding line units 2. The switching means 3 comprises a plurality of individual switching elements that form a switching network. The switching means 3 is the actual switching location of the switching equipment 1. Further, the switching equipment 1 comprises a control unit 4 fashioned, for example, in the form of a microprocessor that forms the heart of the switching equipment 1 and serves for the drive and monitoring of the individual line units 2 as well as of the coupling means 3. Among other things, the control unit 4 sees to the synchronization of the individual line units 2 to the internal clock of the switching equipment 1 and for defining the physical connections between the individual line units 2 that are to be realized by the switching means 3. The control unit 4 thus determines via which path or, respectively, via which line unit 2 the communication data received via a different line unit 2 are to be forwarded or, respectively, output.

Further, the switching equipment 1 shown in Figure 1 comprises a memory 7 in which the data of the network topology of the corresponding communication network are comprehensively stored. Particularly stored in this memory 7 are how many and which other network nodes the communication network comprises, which connecting lines or, respectively, connecting paths exist between the individual network nodes and what transmission properties (such as, for example, transmission capacities or transmission statusses) these transmission paths comprise, etc.

The pre-calculated, standard connecting paths to the individual, potential destination nodes of the communication network that have already been explained above are stored in a further memory 6. As has already been explained, it is known from the Prior Art to pre-calculate specific, standard connecting paths to the

individual, potential destination nodes of the communication network, whereby these standard connecting paths can, for example, respectively represent the shortest connecting path from the switching equipment 1 to another potential destination node of the communication network. Specific, standard connecting paths as well as the corresponding connection parameters or, respectively, connection properties (such as, for example, transmission capacity or transmission status) are thus stored in the memory 6 in destination node-specific fashion. However, it is not absolutely necessary to store the connection parameters for every connecting path in the memory 6 since, in principle, these information are already deposited in the memory 7. In order, however, to keep the connection setup times as short as possible, it is advantageous to deposit the corresponding connection parameters or, respectively, connection properties at the same time for each connecting path deposited in the memory 6. It is assumed in the exemplary embodiment shown in Figure 1, that, in addition to comprising the switching equipment 1, the corresponding communication network comprises a further N, other switching equipment that serve as potential destination nodes for a communication connection with the switching equipment 1. One or more standard connecting paths can be stored for each potential destination node.

The switching equipment 1 also comprises a further memory 5 that serves as dynamic connecting path memory. The memory 5 is initially empty at the initial commissioning of the switching equipment 1.

The function of the switching equipment shown in Figure 1 or, respectively, the control unit 4 thereof is as follows.

When a connection inquiry or, respectively, a connection request is received via one of the line units 2, the control unit 4 must first determine a suitable connecting path to the requested destination node before the setup of the corresponding connection, whereby, in particular, the connecting path must do justice to quality demands made of the requested connection (for example, bandwidth, transmission rate, etc.) that are potentially prescribed in user-specific fashion. To this

end, the control unit 4 initially searches the standard connecting paths to the desired destination node that are stored in the memory 6. On the basis of the connection properties of the corresponding, standard connecting paths to the requested destination node that are likewise deposited in the memory 6, the control unit 4 can determine whether the memory 6 comprise [sic] a connecting path to the requested destination node that is suited for the requested connection properties. When this is the case, the corresponding connecting path is read out from the memory 6 and employed for the connection setup. When, however, the control unit 4 has not found a suitable connecting path to the requested destination node in the memory 6, the control unit 4 (with reference to the network topology data stored in the network topology memory 7) determines a suitable connecting path to the requested destination node that, in particular, meets the quality demands of the connection request.

Subsequently, this alternative path determined by the control unit 4 is entered in the dynamic connecting path memory 5. The entry ensues destination node-specifically and can, as shown in Figure 1, also comprise the connection parameters or, respectively, transmission properties of the corresponding, identified connecting path. The entries in the dynamic memory 5 thereby ensue in the sequence of the determination of the corresponding connecting paths by the control unit 4. Advantageously, the determined connecting paths are therefore stored in the memory 5 in the form of an FIFO stack. As can be derived from Figure 1, the dynamic memory 5 is not limited to one entry per potential destination node; rather, a plurality of connecting paths (potentially with different transmission properties) can be entered fr each destination node. After entry of a connecting path in the memory 5, the corresponding connecting path determined by the control unit 4 is employed for the connection setup to the requested destination node. The entries in the memory 5 also remain stored in the memory 5 beyond the connection duration of the respectively corresponding connecting path.

When further connection requests are subsequently received at the switching equipment 1, the control unit 4 searches not only the pre-calculated,

standard connecting paths to the requested destination node that are stored in the memory 1 but also searches the entries deposited in the dynamic memory 5. Only when suitable connecting paths to the requested destination node are found neither in the memory 6 nor in the dynamic memory 5 does the control unit 4 again determine a suitable connecting path on the basis of the network topology data stored in the memory 6 and subsequently enter this in the memory 5.

The scope of the memory 5 can be either permanently prescribed or variable. Before entry of a newly determined connecting path into the memory 5, the control unit 4 regularly monitors the memory occupation of the memory 5. When a newly determined connecting path is to be entered into the memory 5 even though a maximum plurality n of memory locations is already occupied, the control unit according to the first exemplary embodiment shown in Figure 1 overwrites the connecting path that has been stored longest in the memory 5. When a connecting path has become invalid in the interim, for example because sub-paths or network nodes that are used have failed, this connecting path is potentially removed both from the memory 6 as well as from the memory 5.

The connection setup times can be shortened on average by employing the dynamic memory 5, since the probability increases substantially that a suitable connecting path is available either in the memory 6 or in the memory 5. In particular, the memory 5 contains only entries of connecting paths that have already met certain quality demands of a corresponding connection request. The entries of the memory 5 are this higher in quality compared to the entries of the memory 6 and therefore contribute to the shortening of the connection setup times since they clearly enhance the probability of finding a suitable connecting path.

After the control unit 4 of the switching equipment 1 -- as described above -- has determined a suitable connecting path to the requested destination node, the control unit 4 generates the aforementioned information element in which the individual network nodes of the communication network that are to be traversed according to the determined connecting path are deposited. This information element

is communicated from the control unit 4 via a corresponding line unit 2 to the first network node of this connecting path and comprises a pointer that always points to the next network node to be approached in the communication network. The network node of the communication network that is approached first thus forwards the pointer to a network node after reception of this information element.

Of course, the switching equipment 1 shown in Figure 1 can also be employed without the memory 6 with the pre-calculated and stored, standard connecting paths to the individual, potential destination nodes of the communication network. In this case, the control unit 4 searches only the entries of the memory 5 upon arrival of a connection inquiry and determines a suitable connecting path on the basis of the network topology data stored in the memory 7 if the memory 5 has no suitable connecting path entries. Subsequently, the newly determined connecting path is deposited in the memory 5 and is then available for the determination of a new connecting path.

It has already been explained with reference to the memory 6 that the storing of the connection parameters of the corresponding connecting path in the memory 6 is optional. This also applies to the entries in the memory 5. With respect to the memory 5, too, it is fundamentally adequate when only the determined connecting path to the corresponding destination node is stored, since the transmission properties or, respectively, connection parameters corresponding to the connecting path are stored in the memory 7. The storing of the connection parameters together with the corresponding connecting path in the memory 5, however, is advantageous since the control unit 4 need not additionally access the entries in the memory 7 subsequently in the determination of a new connecting path in order to identify the corresponding transmission properties of the respective connecting path.

Figure 2 shows a second exemplary embodiment of the inventive switching equipment.

The switching equipment 1 shown in Figure 2 as well as the function thereof essentially corresponds to the switching equipment shown in Figure 1.

According to the second exemplary embodiment, however, the switching equipment 1 also comprises an overflow counter 8. This overflow counter 8 acquires the plurality of overflows of the dynamic connecting path memory 5. I.e., the counter reading of the overflow counter 8 is always incremented by 1 when the control unit 4 wishes to enter a new connecting path in the memory 5 even though a number of connecting paths corresponding to the predetermined maximum plurality n is already stored. The control unit can determine the number of "overflows" of the memory 5 during a defined time span on the basis of the counter reading of the overflow counter 8 and can correspondingly adapt the memory scope of the memory 5 dependent thereon, i.e. raise or lower the maximum plurality n of the entries of the memory 5. When the maximum plurality n of entries of the memory 5 was raised or lowered, the control unit 4 in a version of the second exemplary embodiment shown in Figure 2 can in turn reset the maximum memory scope n of the memory 5 to the original value after the expiration of a corresponding time span.

Another characteristic of the exemplary embodiment shown in Figure 2 is the fact that, in addition to the data shown in Figure 1, the control unit 4 also stores the frequency of use of each connecting path deposited in the memory 5. This means that, given employment of a connecting path stored in the memory 5, the control unit likewise increments the counter of this connecting path stored in the memory 5 by 1. This version makes it possible for the control unit 4 to overwrite the least frequently employed connecting path of the memory 5 with a newly determined connecting path when the maximum plurality n of memory locations of the memory 5 is already occupied.

Particularly as a result of monitoring the frequency of use of each connecting path deposited in the memory 5, the memory 5 forms a self-optimizing connecting path table. The quality of the entries of the memory 5 increases with the operating duration of the switching equipment 1 or, respectively, with the plurality of connections requests arriving at the switching equipment. This self-optimizing

connecting path table assures that connecting paths that are only used seldom or not at all do not remain stored in the dynamic memory 5 over a longer time.

By employing the dynamic memory 5, i.e. a memory whose content dynamically changes with the operating duration of the switching equipment, only a few or, respectively, potentially absolutely no standard connecting paths need be calculated in advance and stored (in the memory 6).

Patent Claims

1. Method for determining a connecting path in a communication network, comprising the steps:

a) determining whether a suitable connecting path to a requested destination node of the communication network is already stored;

b) when, in step a), a suitable, stored connecting path has not yet been identified, determining a suitable connecting path to the requested destination node on the basis of stored network data that describe the communication network, and storing the connecting path, so that this is available for a new determination of a connecting path in step a); and

c) communicating path information corresponding to the connecting path determined in step a) or b) to network nodes that are a component part of the determined connecting path in order to set up the determined connecting path to the requested destination node.

2. Method according to claim 1, characterized in that a connecting path to the requested destination node is considered as suitable connecting path in step a) or b) when the corresponding connecting path leads from an originating node of the communication network to the requested destination node and specific transmission properties for a data transmission to the destination node are met.

3. Method according to claim 1 or 2, characterized in that a plurality of standard connecting paths to specific network nodes of the communication network are permanently stored in advance, these being checked in step a) together with connecting path previously determined and stored according to step b).

4. Method according to one of the preceding claims, characterized in that only a specific, maximum plurality (n) of determined connecting paths are stored in step b).

5. Method according to claim 4, characterized in that, given determination of a new, suitable connecting path in step b), the connecting path previously stored longest according to step b) is erased when a plurality of connecting paths that

corresponds to the maximum plurality (n) has already been previously determined and stored according to step b).

6. Method according to claim 4, characterized in that, given determination of a new, suitable connecting path in step b), the connecting path previously stored according to step b) and used least according to step c) is erased when a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b).

7. Method according to one of the claims 4-6, characterized in that the maximum plurality (n) of the connecting paths that can be stored according to step b) is variable.

8. Method according to claim 7, characterized in that the plurality of overflow cases is counted wherein a new connecting path has been determined according to step b) and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b); and in that the maximum plurality (n) of connecting paths that can be stored according to step b) is set dependent on the number of overflow cases.

9. Method according to claim 7 or 8, characterized in that, when a new connecting path has been determined according to step b) and is to be stored even though a plurality of connecting paths that corresponds to the maximum plurality (n) has already been previously determined and stored according to step b), the maximum plurality (n) of connecting paths that can be stored according to step b) is raised for a specific time span and is in turn reset after the expiration of the specific time span.

10. Method according to one of the preceding claims, characterized in that the steps a) - c) are automatically implemented by control means (4) in a switching equipment (1) that forms a network node (K_1 - K_{10}) of the communication network.

11. Switching equipment (1) for a communication network, comprising a plurality of line units (2) that are respectively connected to at least one terminal equipment (EG_{11} - EG_{43}) or to at least one further switching equipment,

comprising first memory means (7) for storing network data that describe the communication network;
comprising second memory means (5) for storing connecting paths that connect the switching equipment (1) to specific destination switching equipment of the communication network; and
comprising control means (4) that, upon reception of a connection inquiry via one of the line units (2) for a connection to a requested destination switching equipment of the communication network, search the second memory means (5) for a suitable connecting path to the requested destination switching equipment and, when it does not find a suitable connecting path in the second memory means (5), determines a suitable connecting path to the requested destination switching equipment on the basis of the network data stored in the first memory means and stores it in the second memory means (5),
whereby the control means (4), after determining a suitable connecting path stored in the second memory means (5) or determining a suitable connecting path on the basis of the network data stored in the first memory means (7), communicate path information corresponding to the suitable connecting path via a corresponding line unit (2) to further switching equipment that are a component part of the suitable connecting path to the requested destination switching equipment in order to set up the connecting path to the requested destination switching equipment.

12. Switching equipment according to claim 11, characterized by third memory means (6) wherein a plurality of standard connecting paths to specific destination switching equipment of the communication network are permanently stored,
whereby, as a result of a connection inquiry for a connection to a requested destination switching equipment, the control means (4) search the third memory means (6) together with the second memory means (5) for a suitable connecting path to the requested destination switching equipment.

13. Switching equipment according to claim 11 or 12, characterized in that the control means (4) monitor the plurality of connecting paths stored in the second memory means (5) with respect to a specific, maximum plurality (n).

14. Switching equipment according to claim 13, characterized in that, after determining a new, suitable connecting path on the basis of the network data stored in the first memory means (7), the control means (4) erase the connecting path previously stored longest in the second memory means (5) in case the control means (4) find that a plurality of connecting paths corresponding to the maximum plurality (n) has already been stored in the second memory means (5).

15. Switching equipment according to claim 13, characterized by counting means for counting the frequency of employment of each connecting path stored in the second memory means (5) for a connection setup to a respectively requested destination switching equipment of the communication network, whereby, after determining a new, suitable connecting path on the basis of the network data stored in the first memory means (7), the control means (4) erase the connecting path previously stored in the second memory means (5) that is employed least in case the control means (4) find that a plurality of connecting paths corresponding to the maximum plurality (n) has already been stored in the second memory means (5).

16. Switching equipment according to one of the claims 13 - 15, characterized by

counting means (8) for counting the overflow cases of the second memory means (5) wherein, after determining a new connecting path on the basis of the network data stored in the first memory means (7), this is to be stored in the second memory means (5) even though a plurality of connecting paths corresponding to the maximum plurality (n) has already been previously stored in the second memory means (5), whereby the control means (4) set the maximum plurality (n) of connecting paths stored in the second memory means (5) dependent on the acquired plurality of overflow cases.

17. Switching equipment according to one of the claims 13 - 16, characterized in that, after determining a new connecting path on the basis of the network data stored in the first memory means (7) and before storing the determined connecting path in the second memory means (5), the control means (4) temporarily increase the maximum plurality (n) of connecting paths that can be stored in the second memory means (5) when the control means (4) find that a plurality of connecting paths corresponding to the maximum plurality (n) has already been previously stored in the second memory means (5).

Abstract

Method and Determination Device for Determining a Connecting Path in a Communication Network

The present invention is directed to a method for determining a suitable connecting path in a communication network as well as to a corresponding switching equipment (1). Given the presence of a connection inquiry to a requested destination node, a check is first carried out to see whether a suitable connecting path to the requested destination node is already stored in a corresponding dynamic memory (5). When this is not the case, a suitable connecting path is determined on the basis of stored network data of the communication network and is subsequently entered in the dynamic memory (5), so that this connecting path is subsequently available for further connecting path determinations. After determining a suitable connecting path, the connection to the requested destination node is set up according to the determined connecting path.

Figure 1

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UNDER THE PATENT COOPERATION TREATY-CHAPTER II

SUBMISSION OF CORRECTED DRAWINGS

APPLICANT: **ROBERT LIEBL**

DOCKET NO: P00,1291

SERIAL NO:

GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE98/03813

INTERNATIONAL FILING DATE: 29 December 1998

INVENTION: **"METHOD AND DETERMINATION DEVICE FOR THE IMPLEMENTATION OF THE METHOD FOR DETERMINING A CONNECTING PATH IN A COMMUNICATION NETWORK"**

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend Figures 1 and as indicated in red in the attached drawing copies.

Respectfully submitted,

(Reg.No. 27,841

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Attorneys for Applicants

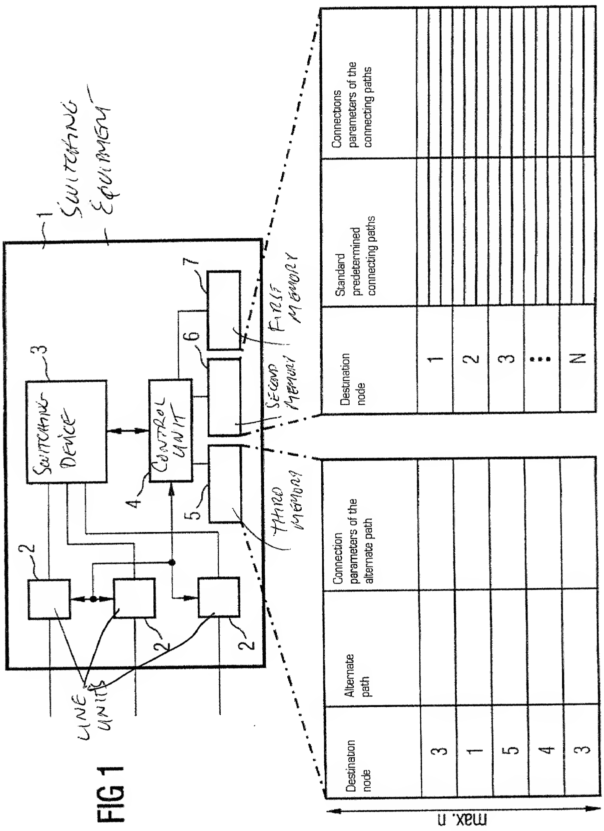
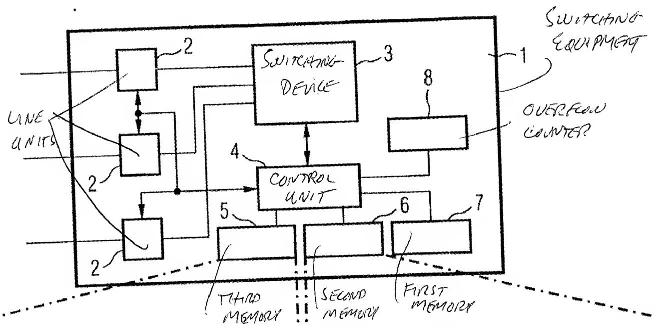

SWITCHING EQUIPMENT
1
SWITCHING DEVICE
3
CONTROL UNIT
4
2
2
2
2
5
6
7
LINE UNITS
FIRST MEMORY
SECOND MEMORY
THIRD MEMORY
Destination node
Standard predetermined connecting paths
Connections parameters of the connecting paths
1
2
3
⋮
N
Destination node
Alternate path
Connection parameters of the alternate path
3
1
5
4
3
max. n

FIG 1

FIG 2



Destination node	Alternate path	Connection parameters of the alternate path	Frequency of use of the alternate path
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1			
5			
4			
3			

max. n

Destination node	Standard predetermined connecting paths	Connection parameters of the connecting paths
1		
2		
3		
⋮		
N		

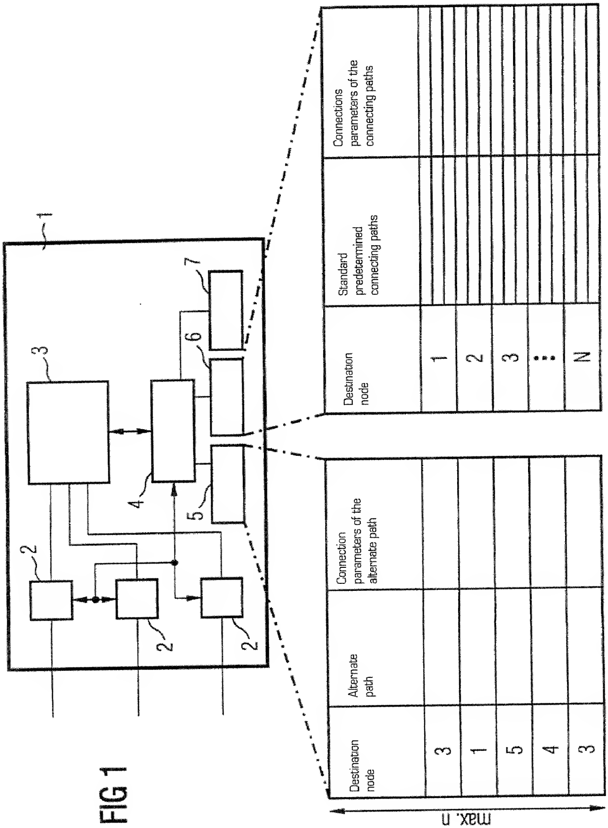
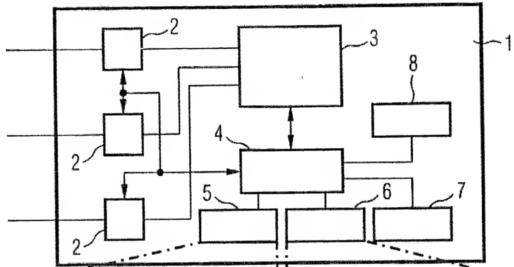

1
2
3
4
5
6
7
Destination node
Alternate path
Connection parameters of the alternate path
3
1
5
4
3
max. n
Destination node
Standard predetermined connecting paths
Connections parameters of the connecting paths
1
2
3
N

FIG 1

FIG 2



max. n

Destination node	Alternate path	Connection parameters of the alternate path	Frequency of use of the alternate path
3			
1			
5			
4			
3			

Destination node	Standard predetermined connecting paths	Connection parameters of the connecting paths
1		
2		
3		
⋮		
N		

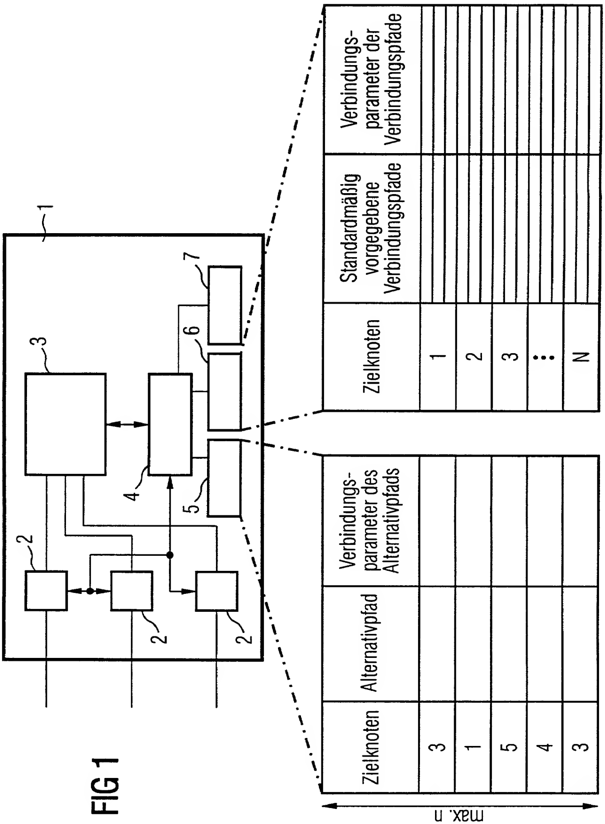
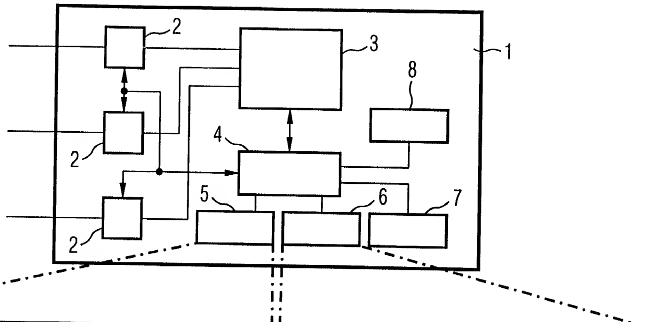

1
2
2
2
3
4
5
6
7
Zielknoten
Standardmäßig vorgegebene Verbindungspfade
Verbindungs-parameter der Verbindungspfade
1
2
3
N
Zielknoten
Alternativpfad
Verbindungs-parameter des Alternativpfads
3
1
5
4
3
max. n

FIG 1

FIG 2

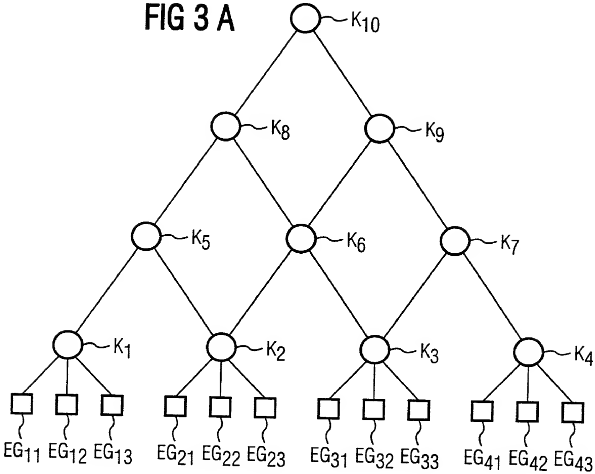


Zielknoten	Alternativpfad	Verbindungsparameter des Alternativpfads	Benutzungshäufigkeit des Alternativpfads
3			
1			
5			
4			
3			

max. n

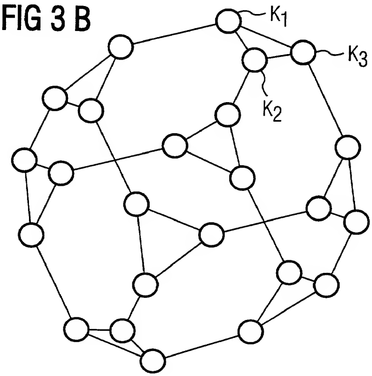
Zielknoten	Standardmäßig vorgegebene Verbindungspfade	Verbindungsparameter der Verbindungspfade
1		
2		
3		
⋮		
N		

FIG 3 A



K10
K8
K9
K5
K6
K7
K1
K2
K3
K4
EG11
EG12
EG13
EG21
EG22
EG23
EG31
EG32
EG33
EG41
EG42
EG43

FIG 3 B



K1
K3
K2

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(zutreffendes ankreuzen)

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abgeändert wurde (falls tatsächlich abgeändert)

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

____
____
____
____

the specification of which

(check one)

☐ is attached hereto.

☐ was filed on ____________ as
PCT international application
PCT Application No. ____________
and was amended on ____________
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

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And I hereby appoint

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1-00

Voller Name des einzigen oder ursprünglichen Erfinders: LIEBL, Robert	Full name of sole or first inventor:
Unterschrift des Erfinders / Datum: Robert Liebl 28.12.1998	Inventor's signature / Date
Wohnsitz: D-93470 Lohberg, Germany DEX	Residence
Staatsangehörigkeit: Bundesrepublik Deutschland	Citizenship
Postanschrift: Thürnstein/Dorfstr. 31	Post Office Addess
D-93470 Lohberg Bundesrepublik Deutschland	
Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Unterschrift des Erfinders / Datum	Second Inventor's signature / Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
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(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

19802599.8	Germany	23. January 1998	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

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(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhangig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

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